



## Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

and a number of the men died. A house standing in the vicinity was so much troubled with those and other snakes, who sought refuge in the cellar, that it was burned down and allowed to remain in ruins, no one caring to live there. Dr. C. H. Yelvington told me that the copperhead *never* bites when coiled up. But he will throw the middle of his body into long, almost rectangular curves, as the above drawing indicates, and with his head and an inch or so of the neck slightly elevated above the ground, is ready to defend himself.

—:O:—

## EXPERIMENTS WITH THE ANTENNÆ OF INSECTS.

BY C. J. A. PORTER.

IN accordance with the suggestion of Dr. A. S. Packard, Jr., in an article published by him in the *NATURALIST*, Vol. XI, page 418, and also in pursuance of the plan hinted at by Mr. L. Trouvelot (*AMER. NATURALIST*, Vol. XI, page 193), I made, during the season of 1878, some pretty extensive experiments on the antennæ of insects with the view of finding out, if possible, what is the function, or functions if there may be several, of this part of the insect economy. I experimented with a great many individuals, and these of many different species of insects, and give below an account of a few of these experiments, together with the conclusions I have ventured to draw from the whole. Not that I would say the experiments are in any way exhaustive, or that the conclusions drawn are altogether correct, but I present them that I may do something to excite others, who may be more competent, to turn their attention and spare moments to this subject, which all will no doubt agree it is certainly time to investigate more freely than it has been heretofore. I have selected from my notes such experiments as seem best to represent the whole, and it will be noticed by those who have read the above-mentioned papers, that in some respects our results differ, while in most instances they agree. The differences, however, may be due to variations of experiment.

1. I found a large humble-bee on a clover stalk a few rods from my room; I caught it by throwing my handkerchief over it, and then carrying it home, I placed it in a glass fruit-can in order to let it recover if in any way it might have been injured by the capture or carrying. When it seemed to have been in sufficient

time, I put it out on the table and let it run around and fly about till I was satisfied it was all right. I then cut off one of the antennæ, cutting away about two-thirds of it. I noticed that it immediately let the stump drop, but otherwise it did not seem to care *at first*. But I soon found that it began to feel dizzy and to fly very unsteadily, and when taken into the middle of the room and let fly toward the window would not always strike it, but would hit the wall often several feet to one side or the other. I then cut off the other antenna in the same way. It soon began to grow weaker and weaker very rapidly and to fly very laboriously, but was still able for some moments after to reach the light of the window, though in a very random manner. On reaching the window for the last time, it buzzed up and down the pane a few times but soon ceased and began to walk back and forth on the sill in a very restless manner, stopping every few inches to rub the stumps of its antennæ with its fore feet and seeming to be in great pain. Soon it became too weak to walk except with apparently great exertion. Finally it crept into a small hole between the sill and the plastering of the wall. On being driven out again it crept under a small stone lying on the sill, and seemed to be trying to get away from the pain, reminding me of the motions of an ox which has been struck a hard blow on the horn. When taken from the window again it did not try to find its way back or even to fly, but crawled feebly over the floor, growing weaker all the time, and if thrown into the air would buzz and fall at once like so much wood. But all this time I noticed its power of direction, as far as I could see, was not at all impaired, as far at least as walking was concerned, and that its sight was as good as ever; for whenever I put my hand, or any moving body, near it, say three feet, it would immediately roll over on one side, tuck the head under the body as if to protect the mutilated antennæ, and at the same time throw up its legs as if to ward off my hand. At length it crawled up the table leg and sat down on the first bead of the leg, some six inches from the floor, and tucking the head under as far as possible, seemed to give up in despair. In about ten minutes I got some sugar for it, but it was so far gone already that when I put the sugar to its mouth I came very near knocking it off the table leg with the straw on which I had the sugar. It took no notice of it except to push it away and wipe off with its feet what I put

on the stumps of the antennæ, and then draw its head under again. It soon crawled further up the table leg to the second bead, where it sat till the next morning. As soon as I came near it the next morning it threw up its feet again to ward me off even before I touched it. It sat in the same position for fourteen hours in all, and at the end of that time I saw it on the floor, but do not know how it got down—whether it fell or came down of itself. It sat in one place on the floor for some time, but at length began to crawl, or rather to drag itself across the room, carrying the antennæ up high as if sore. When it came to the sun on the floor through the window, it stopped, turned its head toward the sun and sat down again as before, and in this position I found it three-fourths of an hour after apparently *dead*. But it was *not* dead. I picked it up and pulled out one of the antennæ to examine it with a microscope. As I drew it, it came out by the roots as it were, leaving a considerable hole in the side of the head. I left the body on the table where it lay perhaps an hour, and I had almost forgotten it when I was surprised by my sister asking me, “When are you going to kill that poor bee and put it out of its misery?” On going back I found it had come to life again and was crawling over the floor as if in great misery, pausing now and then to rub its mutilated head with its fore feet. I thought it was time to kill it, and did so. I think it had fainted on account of the pain.

2. I found on my window, where it had been for several hours, a smaller humble-bee; I think, as I did not preserve it, one of the kind which nest in the cornice of buildings, &c. It would not notice anything, bad or good, which I put on its antennæ; but when I cut off one, it seemed to hurt it much and make it fly very much at random from place to place. When I cut off the other it lost all ambition and strength, and did not try to sting me, though I must say I gave it only a moderate chance, as I handled its abdomen rather carefully. It was soon too weak to bear the weight of its own body or to stand upright, but would tumble over on its side or back and not move till disturbed. I laid it on its back and walked on an errand a mile and a half from home; when I returned I found it had not moved. I then killed it.

But it might be well to say here that all humble-bees are not so affected; some hardly seem to know they have antennæ at all,

not even by the loss of them ; others again get very sick, and then after awhile recover.

3. On the same day I caught a long fly-like insect on my window. Its antennæ seemed very tender, even to the slightest touch of a straw. When one was cut off it did not seem to hurt it much. But when I put some pepper-sauce on the other it contracted it very much and ran around as if it were crazy. Once or twice it tried to clean it off with the mouth, but seeming to get a taste of the sauce, it did not use its mouth so again, but took its feet to it, and at the same time tried every few steps to clean both mouth and antennæ by rubbing them on the window sill. The stump was not so much affected by the sauce, though it noticed it also. I might remark here that *many* grasshoppers act in much the same way under similar treatment.

4. I caught five common crickets with the intention, at first, of trying to find out whether the power of direction resides in the antennæ. Of one I cut off the right antenna, of one the left and of two both, leaving the other two whole. I then turned all five out on the floor. The deantennized ones did not notice it at first, but after a while they drew the remaining stumps several times through the mouth and then let them alone. I could find no difference of movement among them, but all seemed as lively as crickets generally are. Failing to find anything like a sense of direction, I caught them again to try if I could find in the antennæ anything like a sense of hearing. Among the other noises I made, I got a large jews-harp and played on it with all my might. But they took no notice of it, at least as far as the antennæ were concerned, but sat in contemptuous silence, though I executed for them, to the best of my ability, many martial airs of the land with now and then a love song or a waltz. And let me say just here that another cricket whose antennæ I had cut away, and which I placed in the kitchen, "sang" all summer long. And also that of all the experiments I have made, I have not been able to find anything like a sense of hearing. Antennæ all seem to be deaf. Next, with these same crickets, I experimented to find a sense of taste in the antennæ. Instead of using things which might taste well to them, I used some table mustard and some pepper-sauce. Putting some of the mustard on the end of a straw I found that when I touched it on the antennæ they would remove them immediately. The stumps were not quite so

sensitive as whole antennæ, as they did not clean it off of them as off the antennæ. The pepper-sauce was, if anything, more distasteful than the mustard (if it might be called taste).

I experimented with crickets many times after with the same results.

5. On June 11th I caught one of the large black and gold-spotted beetles common in wheat fields. I gave him, *via* the antennæ, all the good and bad tasting things I could get hold of, but he cared not a bit. Nor did he care any more when I cut them off, and though I kept him a day after, he was as full of life at the end of that time as before. This may be taken as a fair representative of *most* beetles. They are a very don't-care set, at least as to their antennæ.

6. Contrast with the last, however, the following case: July 9th I caught one of those Coleoptera which so many people mistake for butterflies on account of the way they fly. It was a triangular insect with yellow and black bands across the wings. It seemed to have nearly all its life concentrated in its antennæ, so that whenever I even pinched one of them a little, it seemed to paralyze the insect. When I cut them off it walked a few inches and then fell, as I thought, dead. I noticed that from the wounds of the head there came out a fluid which had a very high power of reflecting light. I placed it under the microscope, and was much surprised to find that, although when it first came out it reflected so much light as to be painful to the eye, it soon changed color and ceased to reflect. In order to examine it more, I ran several pin holes through the body and then concentrated enough light on it to scorch the hand, when to my greater surprise it began to crawl away from the heat. It had been in a state of insensibility for at least fifteen minutes. It revived very slowly, but was able to drag itself along, when I killed it.

7. This one has reference to smell, and was one of those beautiful brown and red and white and variegated butterflies so common most of the summer. Having split one end of a long broom-straw, I placed in the cleft a piece of gum camphor, then taking the wings of the butterfly between the thumb and finger of one hand, I presented to its antennæ the straw, first one end and then the other. It did not notice either end of the straw as long as I moved it about close to the antennæ; but whenever I

put the camphor end near to its head and mouth-parts, it would begin to struggle with all its might as if to get away from the fumes of the camphor; thus showing not only that it disliked the smell of camphor, but also that it did not smell with its antennæ. After experiments have shown the same thing of other insects.

I will add here that this butterfly (as also many other species) was little or not at all affected by deantennization, but flew about the windows for many hours afterward, and when finally turned out of the door, flew away as happy as ever.

8. This case represents many others which seem to me to point to a sense residing in the antennæ, and which out of respect to old custom and belief I call feeling, for want of a better name. I found a young grasshopper-like insect sitting on the edge of a bucket of water. I found that on putting my finger to one side or the other of its head, it would throw the antennæ, which was two or three times the length of the body, on that side, towards my finger, and if it could reach it would touch it, though very slightly, as if to feel for it. If I moved my finger to the other side, it used the other antennæ in the same way, or if I put my finger where it could use both at the same time, as in front, or above, or behind it, it did so. I do not wish, however, to be understood to say that the sense of touch lies in the antennæ.

9. Add, lastly, to these the following: Toward the latter end of summer an old gentleman sent me for experiment a large specimen of the common crab. I placed it in a bucket of clear water and then found that whenever I put anything anywhere near it, it would throw out its antennæ, on one side or the other, and touch it slightly, much as the one last given. When left to itself it would invariably sit with the antennæ in a horizontal position and at right angles with the line of the body. But when I cut off one it instantly pointed the stump forwards and upwards while it held the other in the same position as before. Otherwise it was not affected by the mutilation, but used the stumps as before. But when I smeared both well with pepper-sauce it would not even feel with them till the water had cleaned them off. It lived many days after deantennization, and seemed to thrive as well as ever.

*Conclusions.*—From all the experiments I have made, of which

the above may be taken as representative, I have been led to make the following conclusions :

1st. The antennæ are not the organ of any one or of any combination of what we call the five senses—hearing, seeing, smelling, touching, tasting. With respect to these the only sense which one would be at all likely to question, would be the last, taste. It is true that insects often seem to be able, in some way or other, to tell the difference between good and bad tasting things when such things are brought in contact with the antennæ. But I do not think we have any more reason for saying that insects taste with their antennæ because they dislike to have such things as pepper-sauce poured on them than we would have for concluding that a man tastes with his nostrils simply because he would object to having them filled with the same fluid. But on the other hand, this *apparent* sense of taste is, in many instances, nothing more than the insect's desire to clean off whatever may be put on its antennæ. Every one knows that they are mostly kept very clean by the insect at all times, and are, as a rule, of all parts of the body most free from extraneous matter. They seldom notice anything put to them unless it be of a nature to adhere to them. But as soon as anything, even pure water, sticks to them, they immediately draw them through the mouth-parts, and if it be anything palatable, as sugar, for instance, they begin to suck at it. But the very fact that often when they get anything distasteful they begin to spit and clean the mouth, is enough to show that they did not get a taste of it before they put it in the mouth. And aside from all this, who ever saw an insect use its antennæ to taste with? Butterflies and similar insects, when probing the deepest flowers, hold them nearly erect. Of many others, such as the bee, wasp, &c., they scarcely reach to the lower part of the head, not to take into account the length of the extended tongue.

2d. I do not think the power of *direction* is in the antennæ. It is true some insects seem to have lost the power of directing their flight when the antennæ are cut off. But besides the fact that *many* others are not so affected, we know that many of those that are, soon recover and are able to move about as well as ever.

3d. Lastly, I am inclined to adopt the opinion of Mr. Trouvelot that the antennæ are the organ of some sense not possessed by us. But I can hardly say with him that this sense is (if I un-



derstand him rightly) supplementary to that of sight. True it seems in many cases as though insects deprived of their antennæ are somewhat blind; but in vastly more instances they do not seem so. Take, for example, almost any beetle one may pick up. Cut off the antennæ and let them run, and we cannot get them to act in any way not as before. Whatever it be it is in a very different manner connected with the life of different insects. In many instances the deprivation of them seems almost fatal; in others again it is scarcely noticed. Cut them off from a sleeping roach and it will barely awake. Take your scissors and snip them from the gray "stinck bug" as it walks over your window sill or on your door step, and it will stop short where it is and sit still for hours in one place. All experiments of this kind are easily performed, and I hope that many who have even a very few moments to spare, will pay some attention to this part of science, so late in being fully investigated. If so, one object, at least, of this paper will be accomplished.

—:O:—

## ON THE POSITION OF THE COMPOSITÆ AND ORCHIDEÆ IN THE NATURAL SYSTEM.

BY JOSEPH F. JAMES.

THE various authors who have, at different times, written on systematic botany, have had different schemes for a natural arrangement of the orders of plants. Some have placed one order at the head of the system, some another. Hardly two seem to agree as to the ones which should follow in a natural sequence. The large majority of writers, if indeed not all, have considered the Polypetalous division of the Dicotyledons the most highly developed, and have placed the Gamopetalæ in the second, and the Apetalæ in the third class. Ever since the time of DeCandolle, in 1813, down to Bentham and Hooker, our latest authorities, the Ranunculaceæ have generally been placed at the head of the flowering plants. It is the intention, in the present paper, to show reasons why this should not be so, and to suggest another and very different arrangement of the orders.

It would be well at the outset to remark that no system of botany is to be regarded as unmodifiable. All opinions, all ideas, are liable to change, and the fact cannot be better stated than was expressed by Lindley, in 1845, in the preface to his *Vegetable*